



**Daisy Lake Dam  
and Spillway Test  
3 August 1983 and  
Associated Observations  
of Fish and Fish Habitat  
in the Cheakamus River**

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DAISY LAKE DAM AND SPILLWAY TEST 3 AUGUST 1983

AND ASSOCIATED OBSERVATIONS OF FISH  
AND FISH HABITAT IN THE CHEAKAMUS RIVER

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Prepared by:

S.P. Blachut, ESS, B.C. Hydro  
R.G. Ferguson, ESS, B.C. Hydro

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## SUMMARY

Safety testing of Daisy Lake Dam on 3 August 1983 involved discharge of a specific volume of water into the Cheakamus River to test engineering structures. Discharge data are available [Daisy Lake Dam Discharge Facilities Tests, 1983, Report No. H 1661, February 1984] from above and below the stations used for environmental observations. Biological observations were made at stations 14.5, 10.5 and 6.7 km from Cheakamus-Squamish confluence, Stations I, II and III respectively. Hydrological observations were made at 6.7 km and 14 km from the confluence. At the time of the test rearing trout and coho were the only anadromous salmonids in the stream. The high discharge (300 m<sup>3</sup>/s) likely flushed some rearing juveniles down and out of the system and the return to normal water levels could have stranded some juveniles.

### Biological Observations

Biological observations were restricted to the possible stranding of juvenile salmonids, which could occur during the latter stage of the test depending in large part on the rate at which the river returned to its normal channel. Pools or sidechannels left perched above the falling river could strand fish. There was a ramping (water level lowering) rate of 0.99 m/h (3.24 ft/h) at Station I and 0.74 m/h (2.5 ft/h) at Station III. This represents a fast drop in river stage after the gates closed.

A total of 57 rainbow trout fry (likely steelhead) were found stranded at Stations I and III after the tests on 3 August. These fish were observed swimming in pools that were draining into cobbled areas, or in isolated pools. In one case a live trout fry was found under cobbles below a drained pool. Live fish in the pools were seen actively swimming down the draining rivulet to disappear with the water among

the cobbles. Rainbow trout represented the smallest fish in the system at this time. Two sculpins and two coho were observed stranded, one coho was actively preying on the smaller trout fry.

There was no assessment of the total number of temporary pools or sidechannels that were created by the change in water levels, nor the total number of fish that might have been involved. Large numbers of invertebrates of different species were observed stranded in the isolated or draining pools and along the recently dewatered banks and bars.

#### Hydrological Observations

Limited observations of channel morphology and bed material samples were made to supplement the fisheries observations. These observations were related to possible effects on salmon redds which would occur with similar flows at other times of year.

Observations at Stations III and IV and air photo interpretation indicated that little morphological change occurred at the peak flows of 300 m<sup>3</sup>/s. Limited bed material samples revealed a mean grain size of 100 mm for the armor layer of cobbles, overlying a coarse sand-fine gravel substrate. This bed material was set in motion to a depth of 30 cm by the test flows at Station IV, whereas no bed movement was detected at Station III. The 30 cm depth of disturbance indicated at one station could disturb eggs in redds, if similar flows are experienced while eggs are in the gravel.

## SECTION 1.0 - INTRODUCTION

A programmed sequence of discharges was carried out at Daisy Lake Dam on 3 August 1984. This was the major part of a test to check the safe operation of the structure under simulated flood conditions. The role of ESS staff was to monitor, observe and report environmental impacts to the fish or fish habitat that were a consequence of the test. To sample possible environmental impacts four stations (Fig. 1) were selected, and observations were made on 2 August, the day prior to the test. These stations were also monitored on 3 and 4 August.

The test released a large volume of water into the Cheakamus River. This river is used by several species of anadromous fish, and major changes in discharge may affect various life stages such as spawning, incubating or rearing. Spawning fish could be displaced and spawning disrupted; incubating eggs could be excavated or silted over and suffocated. Rearing juveniles could be displaced from their prime habitat, or they could be stranded if the stage dropped quickly since they tend to remain close inshore, especially during rising water levels.

Effects on spawning and incubating habitat conditions were sampled by recording certain hydrological parameters such as bed load movement. Stranding of juveniles was sampled by direct observation of the newly emerged river bank. The timing of the test was selected to avoid possible impacts to spawning fish or incubating eggs. However, rearing coho salmon juveniles and steelhead trout were present.

The test release discharge was matched by a natural event on 11 July 1983, 23 days earlier. This earlier natural event would have also affected the fish in the river and could have reduced the numbers of fish present on 3 August 1983, the day of the test.



## SECTION 2.0 - FISH OBSERVATIONS

During the test when discharges and river stages were high no fish were observed. After the test juvenile fish were observed in pools left along the river banks by the receding water. Time for observations after the test was limited by darkness.

Stranding was observed at three of the four stations, and at additional points. Quantification of the numbers of pools or fish stranded was not attempted. The emphasis was to document the conditions and characteristics of stranding, and the species involved.

### 2.1 DAY PRIOR TO TEST

Seining in the Cheakamus River is difficult at most locations because of the bouldery nature of the stream but it is most difficult in upper Paradise valley (Fig. 2), close below the canyon. An electro-fisher would have been a preferable tool for quantitative data. Three stations were established with the uppermost, Station I, being close below the canyon at 14.5 km from the Squamish-Cheakamus confluence, it was predominantly cobbles and large boulders. Cobbles also dominated at Station II, at 10.5 km and at Station III, 6.7 km or just above the "Hydro bridge".

A summary of the seine catches (all fish enumerated and identified, then returned alive to the river) on 2 August 1983 were as follows:



Figure 2

Station I Large cobbles and boulders typified this station. Seining was difficult here on 2 August 1983.

| <u>Station</u> | <u>Catch</u> | <u>Size Range</u> | <u>Comments</u>                                                     |
|----------------|--------------|-------------------|---------------------------------------------------------------------|
| I              | 22 rt        | 24-32 mm (av. 28) | Seven hauls, three unproductive, w. temp 14.5°C, difficult to seine |
|                | 10 co        | 50-80 mm (av. 66) |                                                                     |
| II             | 1 rt         | 98 mm             | Cobbles approx. 93 mm diameter<br>Sculpin not identified            |
|                | 2 ch         | 75-80 mm          |                                                                     |
|                | 1 sc         | 90 mm             |                                                                     |
| III            | 11 ch        | 65-80 mm          |                                                                     |

Species are: "rt" is rainbow trout, "co" is coho, "ch" is chinook. Positive separation of coho from chinook was difficult and there may be some error in the identification of these two species above.

## 2.2 DURING THE TEST

On 3 August 1983 the observers at the three stations noted water level and other changes that occurred during the tests. At Station I observations began at 1000 hours and a simple stage level record was kept. At Station III the records from the District of Squamish-municipal established a water level gauge just upstream from the Hydro bridge from which observations were made during the test. The attached figure (Fig. 3, data in Table 2-1) illustrates the relative stages and times during the period of observation. After the relatively (1330 to 1700 hours) long peak, the sharp drop to earlier water levels occurred in 50 minutes (from 1700 hours to 1750 hours) at Station I, and from 1745 hours to 1845 hours at Station III.

The rapidly falling water levels left pools scattered along the river side, above the regular river channel. These pools were temporary and actively draining (see Fig. 4). Stranded fish were observed in several of these pools. The numbers and species of fish observed stranded at each station are shown in the following table. This was not an exhaustive search for stranded fish, simply observations along the left side of the river at each station.

Figure 3  
CHEAKAMUS RIVER WATER LEVELS  
DURING 3<sup>RD</sup> AUGUST, 1983  
AT TWO STATIONS

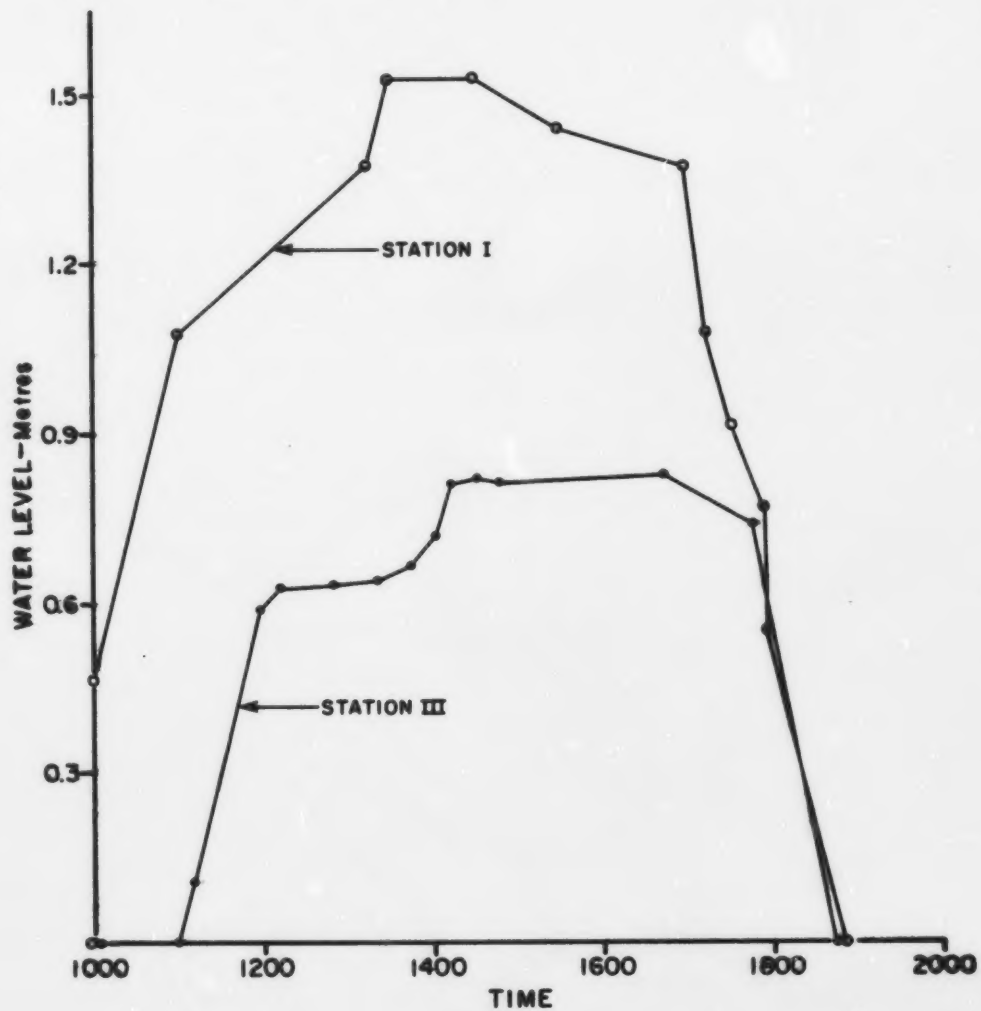


TABLE 2-1

CHEAKAMUS WATER LEVELS DURING DAM TEST OF 3 AUGUST 1983  
AT STATION I (14.5 km) AND AT STATION III (6.7 km)

| <u>Station I</u> |                      | <u>Station II</u> |                      |
|------------------|----------------------|-------------------|----------------------|
| <u>Time</u>      | <u>Level<br/>(m)</u> | <u>Time</u>       | <u>Level<br/>(m)</u> |
| 1000             | 1.5                  | 1000              | 0.0                  |
| 1100             | 3.5                  | 1100              | 0.0                  |
| 1320             | 4.5                  | 1110              | 0.35                 |
| 1330             | 5.0                  |                   |                      |
| 1430             | 5.0                  |                   |                      |
| 1530             | 4.7                  | 1200              | 1.95                 |
| 1700             | 4.5                  | 1220              | 2.00                 |
| 1717             | 3.5                  | 1245              | 2.10                 |
| 1730             | 3.0                  | 1320              | 2.10                 |
| 1739             | 2.5                  | 1345              | 2.20                 |
| 1750             | 1.8                  | 1400              | 2.35                 |
| 1850             | 0.0*1                | 1415              | 2.65                 |
|                  |                      | 1430              | 2.70                 |
|                  |                      | 1445              | 2.65                 |
|                  |                      | 1645              | 2.70                 |
|                  |                      | 1745              | 2.45                 |
|                  |                      | 1845              | 0.0                  |

---

\*1 Level at 1850 considered 0.0 feet.



Fig. 4 - Station I

An isolated pool containing 26 rainbow trout fry,  
1 coho, juvenile, 1 sculpin, 3 August 1983.  
Stranded by rapidly falling river stage following  
test.

| <u>Station</u> | <u>Catch</u>           | <u>Size Range</u>                   | <u>Comments</u>                       |
|----------------|------------------------|-------------------------------------|---------------------------------------|
| I              | 26 rt<br>1 co<br>1 sc  | 95 mm                               | Preying on rt                         |
| II             |                        |                                     | Water discoloured, could not see fish |
| III            | 16+ rt<br>1 co<br>1 sc | 30-40 mm<br>ca. 50 mm<br>ca. 100 mm |                                       |

### 2.3 DAY FOLLOWING TEST

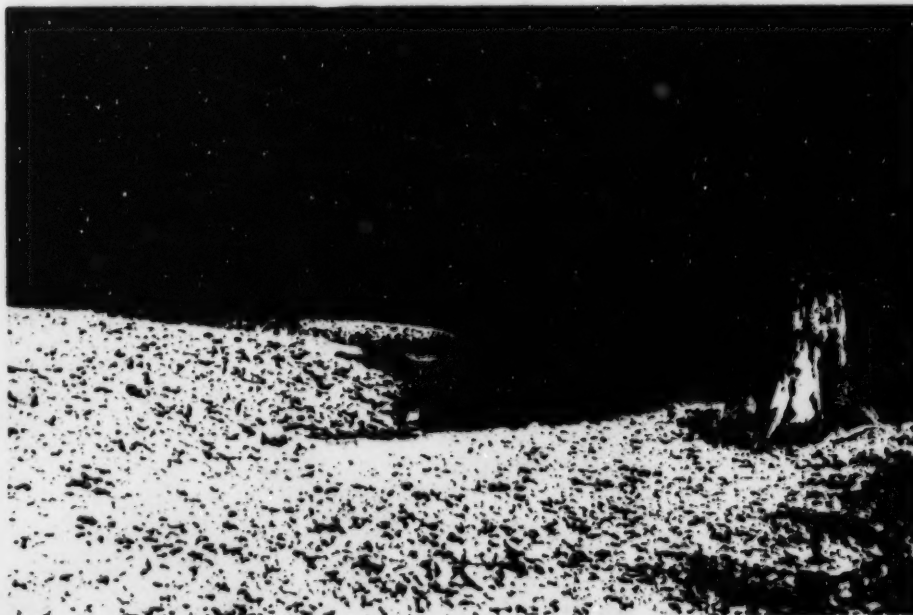
Observations on the day following the tests (4 August 1983) showed that all pools had disappeared at Station I, and one coho (61 mm) only was seined from the river. At Station II, seining in the river caught two rainbow trout (30 and 150 mm) and 1 sculpin (113 mm). In a pool within a flood sidechannel 14 rainbow trout (31 to 41 mm) fry were observed (see Fig. 5). Downstream from this pool one rainbow trout fry (30 mm) was found by turning over cobbles. It was alive and resting in a damp depression below the stone. At Station III, seining yielded (four hauls) three chinook (75 to 79 mm).

A check of the overflow sidechannel (Fig. 6) above the Hydro bridge showed that it was dry above the road, but was spring-fed below. Within the spring-fed area there were 20 to 30 rainbow trout fry. The spring produced an appreciable flow, but it was in an open channel and noticeably warmer below the spring. This "overflow channel" was observed by G. Carlson, B.C. Fish and Wildlife Branch to contain stranded trout.

Stranding of rainbow trout fry noted in several of the temporary pools along the river's edge occurred when the river dropped considerably faster than the rate at which the pools drained. Larger fish were much less frequently observed, but then this could be a reflection of their relative scarcity, compared to trout fry. The one coho observed



Trout found under cobbles, on sand.



Isolated pool with more than 14 trout fry stranded in it.

Figure 5

Station II Overflow sidechannel 4 August 1983.

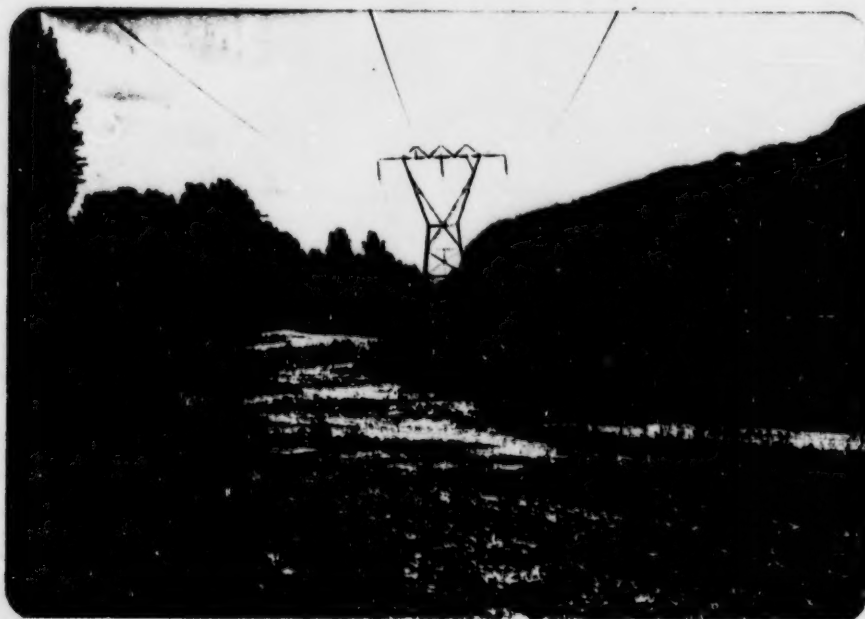


Fig.6 - Overflow Channel near Station III  
which flowed through trees, across  
road and along right-of-way. It  
stranded trout according to B.C.  
Fish and Wildlife.

stranded was actively preying on the stranded trout fry. The trout fry in this pool (Fig. 4) were swimming about the pool, and when they encountered the outlet rivulet they actively darted into it and swam with the flow. In this and many others of the temporary pools seen, the outlet rivulet and fish disappeared into the cobbles after a metre or two.

No attempt was made to quantitatively assess the numbers of pools, nor the numbers of fish that were involved. The amount of time required to simply turn over the cobbles from one pool was prohibitive and we did not attempt to assess the fate of the fry at most stations. This was especially so because the test was completed late in the day, and river levels were still dropping at dusk.

Large numbers of aquatic invertebrates, prime fish food, were also observed stranded in the pools and on the newly exposed shore.

## SECTION 3.0 - HYDROLOGY OBSERVATIONS

### 3.1 METHODS

Standard techniques (Bray, 1971; Kellerhals, Church and Bray, 1976) were used to describe the morphology of the Cheakamus River below Daisy Lake, and to take a limited number of bed material samples. Selected sites were photographed before, during and after the flow test in an attempt to document morphological change attributable to the event.

A technique for measuring depth of gravel disturbance was tested, which was designed and constructed by W. Field, of Canada Department Fisheries and Oceans. Each gravel displacement indicator unit consisted of a 2 m length (76 links) of 3/8-inch galvanized chain attached securely from the upstream link to a rebar anchor by 4.25 m of soft rebar wire. The attachment of the chain to the anchor with wire allowed the chain to be pulled taut in a downstream direction along the gravel surface, well removed from any effects of the anchor on gravel movement. The anchor was a 1 m length of 3/4-inch reinforcing rod driven vertically into the gravel with a 5 kg sledgehammer until the top of the rebar was level with the surface of the surrounding gravel.

The top of the rebar anchor, the marked centre link of chain and the surrounding bar surface were all surveyed to a benchmark on shore, both prior to and following the test.

### 3.2 OBSERVATIONS

Field data collected on 2 and 3 August 1983, and air photo interpretation are reported in this section, with a brief interpretation of the results in the following section (Section 4.0).

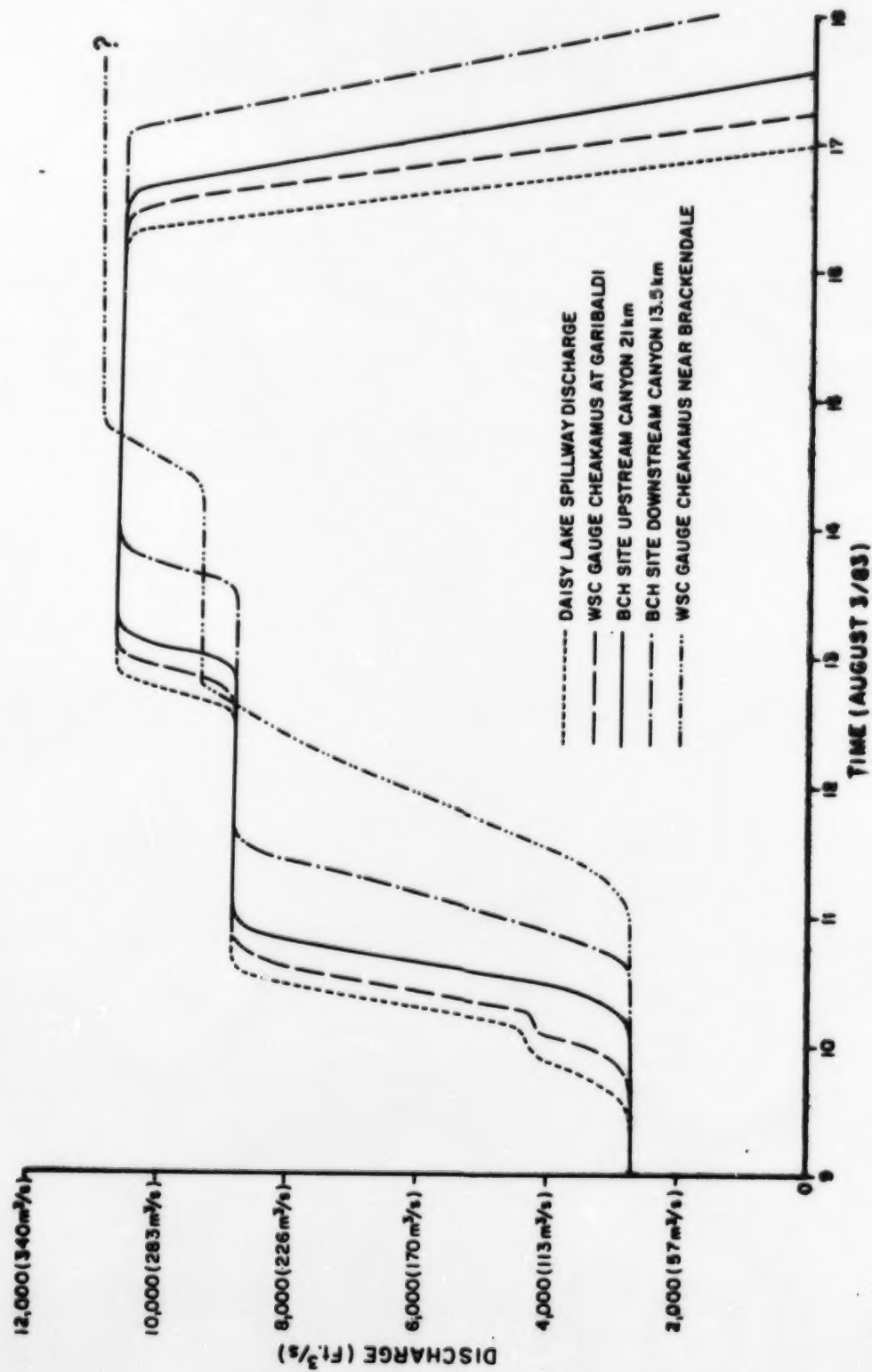
(a) Hydrology

The Cheakamus River has a basin area of 1050 km<sup>2</sup>, of which 780 km<sup>2</sup> are above Daisy Lake. The mean annual flow of the Cheakamus River near Brackendale (Water Survey of Canada Station No. 089A043) for the period of record (1957 to 1976) since regulation is 34.8 m<sup>3</sup>/s (1230 ft<sup>3</sup>/s). The highest mean monthly flow is 93.4 m<sup>3</sup>/s (3300 ft<sup>3</sup>/s) in June during the snowmelt runoff, and the lowest mean monthly flow of 15.8 m<sup>3</sup>/s (557 ft<sup>3</sup>/s) occurs in March. The extreme values on record are 860 m<sup>3</sup>/s (30,500 ft<sup>3</sup>/s) on 21 October 1963 for a maximum instantaneous discharge and 712 m<sup>3</sup>/s (25,140 ft<sup>3</sup>/s) on 27 December 1980 for a maximum mean daily discharge.

The flows released during the test of 3 August 1983 are shown in Fig. 7 for two Water Survey of Canada Stations and two B.C. Hydro observation sites. The B.C. Hydro proposed spillway release schedule was 3700 ft<sup>3</sup>/s (105 m<sup>3</sup>/s) from 0900 to 0925 hours, up to 8,800 ft<sup>3</sup>/s (250 m<sup>3</sup>/s) by 1020 hours, peaking at 12,500 ft<sup>3</sup>/s (354 m<sup>3</sup>/s) by 1220 hours, with gates closed by 1645 hours. Preliminary data collected by Water Survey of Canada at the Cheakamus River at Garibaldi Station indicates that 8900 ft<sup>3</sup>/s (252 m<sup>3</sup>/s) was gauged from 1030 to 1205 hours and 10,700 ft<sup>3</sup>/s (303 m<sup>3</sup>/s) was gauged from 1340 to 1535 hours. The WSC Station Cheakamus River near Brackendale recorded 9400 ft<sup>3</sup>/s (266 m<sup>3</sup>/s) from 1236 to 1414 hours, and 10,998 ft<sup>3</sup>/s (311 m<sup>3</sup>/s) after 1414 hours.

A flow event on the Cheakamus which may have significance for the following discussion of morphology was recorded 11 to 13 July 1983. Preliminary data for the Station Cheakamus River near Brackendale indicates a mean daily flow of 154 m<sup>3</sup>/s (5,440 ft<sup>3</sup>/s) on 11 July, 303 m<sup>3</sup>/s (10,700 ft<sup>3</sup>/s) on 12 July and 225 m<sup>3</sup>/s (7,950 ft<sup>3</sup>/s) on 13 July. An instantaneous peak discharge of 412 m<sup>3</sup>/s (14,550 ft<sup>3</sup>/s) was recorded at 0200 hours on 12 July.

Figure 7  
FLOW DATA, CHEAKAMUS RIVER  
AUGUST 3/83



During the tests on 3 August velocities were measured by W. Field, DFO from a foot suspension bridge at km 14 and are presented for comparison with the B.C. Hydro water level data from km 13.5 (Table 3-1). At flows greater than 252 m<sup>3</sup>/s (8,900 ft<sup>3</sup>/s), velocities exceeded the instrument capabilities. However, the data indicate that flows of greater than 252 cms resulted in velocities in excess of 3 m/s (10 ft/s) at the station.

(b) River Morphology

The Cheakamus River below Daisy Lake can be subdivided into four roughly homogeneous geomorphic reaches (Fig. 1). The reaches, as interpreted from aerial photography, are:

- |         |          |                                                                                                                               |
|---------|----------|-------------------------------------------------------------------------------------------------------------------------------|
| Reach 1 | km 0-3   | Squamish-Cheakamus confluence to the Cheekye-Cheakamus confluence, split channel, aggrading, bank protection works.           |
| Reach 2 | km 3-8   | Lower Cheakamus reach - irregular channel with occasional vegetated islands, diagonal and point bars.                         |
| Reach 3 | km 8-16  | Middle Cheakamus reach - confined partly entrenched, straight channel, Culliton Creek, important tributary.                   |
| Reach 4 | km 16-25 | Upper Cheakamus reach-entrenched, structurally controlled, canyon with rapids and falls. Rubble and Chance Creek tributaries. |

The two middle reaches of the Cheakamus River are of prime concern to spawning salmonids and were the focus of the limited sampling and observation program of this study. Classification forms summarizing the key geomorphic characteristics of the middle and lower Cheakamus reaches are attached (Tables 3-2 and 3-3 respectively).

TABLE 3-1  
CHEAKAMUS RIVER WATER VELOCITIES

| Time<br>(PDT) | Velocity<br>(ft/s) | Velocity Range | Water Levels<br>at BCH Site<br>at km 13.5<br>(m) | Remarks                         |
|---------------|--------------------|----------------|--------------------------------------------------|---------------------------------|
| 08:50         | 5.5                |                | -0.1                                             | Marsh McBirney electronic meter |
| 09:50         | 5.8                | 5.6 - 6.0      | -0.1                                             | Sensor 1 ft below water sfc     |
| 10:00         | 5.3                | 5.2 - 5.4      | -0.1                                             | Upwelling turbulence developing |
| 10:05         | 6.0                | 5.8 - 6.3      | -0.1                                             |                                 |
| 10:20         | 5.6                | 4.8 - 5.6      | -0.1                                             |                                 |
| 10:25         | 6.4                | 6.2 - 6.6      | -0.09                                            | Sounds of gravel rolling        |
| 10:35         | 6.6                | 6.3 - 6.8      | -0.02                                            |                                 |
| 10:45         | 6.6                | 6.4 - 6.8      | +0.03                                            |                                 |
| 10:55         | 7.2                | 7.2 - 7.4      | +0.16                                            | Loud gravel noise               |
| 11:00         | 8.2                | 8.0 - 8.5      | +0.30                                            |                                 |
| 11:20         | 9.4                | 9.0 - 9.8      | 0.67                                             | Small surges in level           |
| 11:22         | 10.0               | 10.0 - 10.8E   | 0.65                                             | 10.0 = top of instrument scale  |
| 11:30         | 10.0+              |                | 0.67                                             | Large swirls developing         |
| 11:45         | 10.5E              | 10.0 - 11.0E   | 0.65                                             |                                 |
| 12:00         | 10.0               | 9.8 - 10.0     | 0.65                                             |                                 |
| 12:15         | 9.8                | 9.6 - 9.9      | 0.66                                             |                                 |
| 12:30         | 10.0               | 9.6 - 10.0     | 0.65                                             |                                 |
| 14:05         | 10.5E              | 10.2 - 10.6E   | 0.96                                             | Water level reaches BM2 nail    |
| 14:30         | 11.0+E             |                | 0.95                                             | Dial needle hard against stop   |
| 16:45         |                    |                |                                                  | Dam spillway shutdown           |
| 17:15         | 10.0               | 9.8 - 10.2E    | 0.20                                             |                                 |
| 17:30         | 9.4                | 9.2 - 9.4      | 0.51                                             | Water sfc 1.7 ft below BM2 nail |
| 17:55         | 7.0                | 6.8 - 7.2      | 0.12                                             | Water sfc 2.9 ft below BM2      |
| 18:05         | 4.8                | 4.6 - 5.0      | -0.06                                            | Water sfc 3.69 ft below BM2     |
| 18:10         |                    |                | -0.10                                            |                                 |
| 18:15         | 4.5                | 4.4 - 4.6      |                                                  |                                 |
| 18:25         | 4.2                | 4.1 - 4.3      |                                                  | Water sfc 4.37 ft below BM2     |

- Note:
1. Velocities were taken from private suspension bridge approximately 75 feet from left bank.
  2. Stream width 190 feet at low water.
  3. Velocity sensor about 2 feet below water sfc at high flow period.
  4. Velocity value is average of a 30 second observation.
  5. Data collected by W. Field DFO.

TABLE 3-2

## GEOGRAPHIC FEATURES - MIDDLE CHEKAMUS

Reach Name: Middle Chekamus Reach No.: km 8-16 Date of Analysis: 2 Aug 83 Analysis By: S. Blachut  
 Scale of air Photos: \_\_\_\_\_ Scale of Map: 1:50 000

NOTE: Complete codes by circling the appropriate number(s). Use "1" for "unknown" and "0" for "not applicable".

## GENERAL DESCRIPTION OF THE TERRAIN IN THE VICINITY OF THE SURVEYED REACH, ABOVE VALLEY

|               |                                   |                      |                       |                       |
|---------------|-----------------------------------|----------------------|-----------------------|-----------------------|
| Terrain:      | Vegetation:                       | Forest Type:         | Land Use:             | Surficial Geology:    |
| 1 mountainous | 0 0 0 not applicable              | 0 0 0 not applicable | 0 0 no cultivation or | 1 bedrock             |
| 2 foothills   | 1 1 1 almost none                 | 1 1 1 deciduous      | 1 1 built-up area     | 2 ground moraine      |
| 3 uplands     | 2 2 2 grass                       | 2 2 2 coniferous     | 2 2 partly cultivated | 3 hummocky moraine    |
| 4 hills       | 3 3 3 shrubs                      | 3 3 3                | 3 3 mainly cultivated | 4 lacustrine deposits |
| 5 plains      | 4 4 4 sparsely forested, 0-25%    | 4 4 4                | 4 4 partly built-up   | 5 glacio-fluvial dep. |
| 6 lowlands    | 5 5 5 moderately forested, 25-75% | 5 5 5                | 5 5 urbanized         | 6 fluvial deposits    |
|               | 6 6 6 heavily forested, 75-100%   | 6 6 6                | 6 6                   | 7 aeolian deposits    |
|               | 7 7 7 swamp or musseg             | 7 7 7                | 7 7                   |                       |

## VALLEY CHARACTERISTICS ABOVE VALLEY FLAT

|                             |                                            |                             |                              |
|-----------------------------|--------------------------------------------|-----------------------------|------------------------------|
| Valley Measurements:        | Slumping of Valley Walls:                  | Vegetation on Valley Walls: | Forest Type on Valley Walls: |
| 0.1-0.7 km within reach and | 0 none                                     | 0 0 not applicable          | 0 0 not applicable           |
| within reach and            | 1 occasional                               | 1 1 almost none             | 1 1 deciduous                |
| immediate vicinity          | 2 frequent                                 | 2 2 grass                   | 2 2 coniferous               |
| Depth: _____                | Length of reach with slumping valley walls | 3 3 shrubs                  | Comments: <u>logging</u>     |
| Top Width: _____            | (contact length in percent of total length | 4 4 sparsely forested       |                              |
| Bottom width: _____         | of banks): _____                           | 5 5 moderately forested     |                              |
|                             |                                            | 6 6 heavily forested        |                              |
|                             |                                            | 7 7 swamp or musseg         |                              |

## TERRACES

|                   |                   |                                                   |
|-------------------|-------------------|---------------------------------------------------|
| Terrace Presence: | Number of Levels: | Comments (in particular land use and vegetation): |
| 0 none            | 2 fragmentary     |                                                   |
| 1 indefinite      | 3 continuous      |                                                   |
|                   | 0 not applicable  |                                                   |
|                   | 1 one level       |                                                   |
|                   | 2 two levels      |                                                   |
|                   | 9 several levels  |                                                   |

## RELATION OF CHANNEL TO VALLEY

|                                                  |                                                                               |                                              |                             |
|--------------------------------------------------|-------------------------------------------------------------------------------|----------------------------------------------|-----------------------------|
| Valley Type:                                     | If No Valley:                                                                 | Underfit:                                    | Local Lateral Constriction: |
| 0 not applicable                                 | 0 valley present                                                              | 0 not applicable or not                      | 0 none                      |
| 1 stream cut valley                              | 1 on alluvial fan                                                             | 1 obviously underfit                         | 1 one                       |
| 2 stream cut valley in wide valley               | 2 on alluvial plain                                                           | 1 obviously underfit                         | 2 two                       |
| 3 wide mountainous valley                        |                                                                               |                                              | 3 several cases             |
| Relation of Channel to Valley Bottom (Vertical): | Relation of Channel to Valley Walls or to High, Resistant Terraces (Lateral): | Comments: <u>affected by flow regulation</u> |                             |
| 0 not applicable                                 | 0 not applicable (no valley or free)                                          |                                              |                             |
| 1 not obviously degrading or aggrading           | 1 occasionally confined                                                       |                                              |                             |
| 2 partly entrenched                              | 1 frequently confined                                                         |                                              |                             |
| 3 entrenched                                     | 1 confined                                                                    |                                              |                             |
| 4 aggrading                                      | 1 entrenched                                                                  |                                              |                             |

TABLE 3-2 - (Cont'd)

| Basin Name: <u>Middle Cheatem</u>                                                                                                                                                                          |                                                                                                                                                                                                      | Reach No.: _____                                                                                                                                                |                                                                                                                                                                                                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>DESCRIPTION OF VALLEY FLAT</b>                                                                                                                                                                          |                                                                                                                                                                                                      |                                                                                                                                                                 |                                                                                                                                                                                                   |
| <b>Presence:</b><br>0 none<br>1 indefinite<br>2 fragmentary<br>3 continuous                                                                                                                                | <b>Extent:</b><br>0 none<br>1 narrow (<1 mi)<br>2 moderate (1-5 mi)<br>3 wide (>5 mi)                                                                                                                | <b>Average width</b> <u>&lt;1</u> mi<br><b>Maximum width</b> <u>1</u> mi<br><b>Channel length with valley flat on left</b> <u>0</u><br><b>on right</b> <u>0</u> | <b>Vegetation:</b><br>0 0 not applicable<br>1 1 almost none or bare<br>2 2 grass<br>3 3 shrubs<br>4 4 sparsely forested<br>5 5 moderately forested<br>6 6 heavily forested<br>7 7 snags or muskeg |
| <b>Forest Type:</b><br>0 0 not applicable<br>1 1 deciduous<br>2 2 coniferous                                                                                                                               | <b>Land Use:</b><br>0 0 not cultivated, not built-up<br>1 1 partly cultivated<br>2 2 mainly cultivated<br>3 3 partly built-up<br>4 4 mainly built-up                                                 | <b>Comments:</b> _____<br>_____<br>_____                                                                                                                        |                                                                                                                                                                                                   |
| <b>CHANNEL DESCRIPTION (near long-term mean)</b>                                                                                                                                                           |                                                                                                                                                                                                      |                                                                                                                                                                 |                                                                                                                                                                                                   |
| <b>Channel Pattern:</b><br>1 straight<br>2 sinuosity<br>3 irregular<br>4 regular meanders<br>5 irregular meanders<br>6 tortuous meanders                                                                   | <b>Islands:</b><br>0 none<br>1 occasional<br>2 frequent<br>3 split<br>4 braided                                                                                                                      | <b>Type of Flow:</b><br>1 uniform water surface<br>2 uniform with rapid<br>3 uniform with boils and irregularities                                              | <b>Meander Dimensions:</b><br>belt width _____ mi<br>wave length _____ mi<br>sinuosity _____                                                                                                      |
| <b>Natural Obstructions:</b><br>0 0 none<br>1 1 logs<br>2 2 beaver dams<br>3 3 boulders (log material)<br>4 4 vegetation                                                                                   | <b>Degree of Obstruction:</b><br>0 0 none<br>1 1 occ. minor<br>2 2 occ. major<br>3 3 frequent minor<br>4 4 frequent major                                                                            | <b>Comments:</b> _____<br>_____<br>_____                                                                                                                        |                                                                                                                                                                                                   |
| <b>LATERAL CHANNEL ACTIVITY</b>                                                                                                                                                                            |                                                                                                                                                                                                      |                                                                                                                                                                 |                                                                                                                                                                                                   |
| <b>Lateral Activity:</b><br>0 0 not detectable<br>1 1 downstream progression<br>2 2 progression and cut-offs<br>3 3 mainly cut-offs<br>4 4 entrenched loop development<br>5 5 laterally active but not 1-4 | <b>Lateral Stability:</b><br>0 stable<br>1 slightly unstable<br>2 moderately unstable<br>3 highly unstable                                                                                           | <b>Comments:</b> <u>some localized instability</u><br>_____<br>_____                                                                                            |                                                                                                                                                                                                   |
| <b>CHANNEL BANKS AND BED</b>                                                                                                                                                                               |                                                                                                                                                                                                      |                                                                                                                                                                 |                                                                                                                                                                                                   |
| <b>Alluvial Bank Material:</b>                                                                                                                                                                             |                                                                                                                                                                                                      |                                                                                                                                                                 |                                                                                                                                                                                                   |
| 0 0 no alluvial banks<br>1 1 clay and silt (cohesive)<br>2 2 silt and sand (non-cohesive)<br>3 3 sand and gravel (<64 m)                                                                                   | 0 0 alluvial bank material<br>1 1 lacustrine deposits<br>2 2 till                                                                                                                                    | 3 3 easily erodible rock<br>4 4 moderately erodible rock<br>5 5 resistant rock<br>6 6 boulders                                                                  | <b>Percentage of left bank in alluvium</b> _____<br><b>Percentage of right bank in alluvium</b> _____                                                                                             |
| <b>Bank Vegetation:</b>                                                                                                                                                                                    |                                                                                                                                                                                                      |                                                                                                                                                                 |                                                                                                                                                                                                   |
| 0 none<br>1 weak<br>2 good<br>3 very strong                                                                                                                                                                | <b>Predominant Bed Material:</b><br>1 sand<br>2 sand with local gravel<br>3 gravel<br>4 gravel with local sand<br>5 sand and gravel                                                                  | <b>Depth of Alluvium:</b><br>0 no alluvium<br>1 shallow<br>2 moderate<br>3 deep                                                                                 |                                                                                                                                                                                                   |
| <b>BED ROCK BELOW CHANNEL</b>                                                                                                                                                                              |                                                                                                                                                                                                      |                                                                                                                                                                 |                                                                                                                                                                                                   |
| <b>Presence of Rock Outcrops in Channel Bed:</b><br>0 none<br>1 one occurrence<br>2 two occurrences<br>3 several occurrences                                                                               | <b>Rock Type at Channel Base:</b><br>0 0 not applicable (none for great depth)<br>1 1 compact clay<br>2 2 shale<br>3 3 limestone<br>4 4 sandstone<br>5 5 conglomerate<br>6 6 granite<br>7 7 volcanic | <b>Erodibility:</b><br>0 0 not applicable<br>1 1 soft cohesive<br>2 2 easily erodible<br>3 3 moderately erodible<br>4 4 resistant                               | <b>Estimated depth of alluvium</b> _____ ft<br><b>Reference or comments:</b> _____<br>_____<br>_____                                                                                              |
| <b>Comments:</b> _____<br>_____<br>_____                                                                                                                                                                   |                                                                                                                                                                                                      |                                                                                                                                                                 |                                                                                                                                                                                                   |

TABLE 3-3

## GEOGRAPHIC FEATURES - LOWER CHEAKAMUS

Reach Name: Lower Cheakamus Reach No.: km 3-8 Date of Analysis: 2 Aug 83 Analysis By: S. Blachut  
 Scale of air Photos: \_\_\_\_\_ Scale of Map: 1:50 000

NOTE: Complete codes by circling the appropriate number(s). Use "1" for "unknown" and "0" for "not applicable".

## GENERAL DESCRIPTION OF THE TERRAIN IN THE VICINITY OF THE SURVEYED REACH, ABOVE VALLEY

Terrain: Vegetation: 0 0 0 not applicable Forest Type: 0 0 0 not applicable or  
 1 1 1 almost none 1 1 1 deciduous  
 2 2 2 grass 2 2 2 coniferous  
 3 3 3 shrubs  
 4 4 4 sparsely forested, 0-25%  
 5 5 5 moderately forested, 25-75%  
 6 6 6 heavily forested, 75-100%  
 7 7 7 swamp or muskeg  
 Comment: \_\_\_\_\_

Land Use: 0 0 no cultivation or built-up area  
 1 1 partly cultivated  
 2 2 mainly cultivated  
 3 3 partly built-up  
 4 4 urbanized

Surficial Geology: 1 1 bedrock  
 2 2 ground moraine  
 3 3 hummocky moraine  
 4 4 lacustrine deposits  
 5 5 glacio-fluvio dep.  
 6 6 fluvial deposits  
 7 7 aeolian deposits

## VALLEY CHARACTERISTICS ABOVE VALLEY FLAT

Valley Measurements:  
 0.7-1 km within reach and within reach and immediate vicinity  
 Depth: \_\_\_\_\_  
 Top Width: \_\_\_\_\_  
 Bottom width: \_\_\_\_\_

Slumping of Valley Walls:  
 0 none  
 1 occasional  
 2 frequent  
 Length of reach with slumping valley walls (contact length in percent of total length of banks): \_\_\_\_\_

Vegetation on Valley Wall:  
 0 0 not applicable  
 1 1 almost none  
 2 2 grass  
 3 3 shrubs  
 4 4 sparsely forested  
 5 5 moderately forested  
 6 6 heavily forested  
 7 7 swamp or muskeg

Forest Type on Valley Wall:  
 0 0 not applicable  
 1 1 deciduous  
 2 2 coniferous  
 Comments: logging

## TERRACES

Terrace Presence: Number of Levels:  
 0 none  
 1 indefinite  
 2 fragmentary  
 3 continuous

Comments (in particular land use and vegetation):  
 affected by regulation

## RELATION OF CHANNEL TO VALLEY

Valley Type:  
 0 not applicable  
 1 stream cut valley  
 2 stream cut valley in wide valley  
 3 wide mountainous valley

Relation of Channel to Valley Bottom (Vertical):  
 0 not applicable  
 1 not obviously degrading or aggrading  
 2 partly entrenched  
 3 entrenched  
 4 aggrading

If No Valley:  
 0 valley present  
 1 on alluvial fan  
 2 on alluvial plain

Underfit:  
 0 not applicable or not obviously underfit  
 1 obviously underfit

Local Lateral Constriction:  
 0 none  
 1 one case  
 2 two cases  
 5 several cases

Comments: \_\_\_\_\_

Relation of Channel to Valley Walls or to High, Resistant Terraces (Lateral):  
 0 not applicable (no valley or free)  
 1 occasionally confined  
 2 frequently confined  
 3 confined  
 4 entrenched

TABLE 3-3 - (Cont'd)

| Beach Name: <u>Lower Chequamegon</u>             |                                  | Reach No.: _____                              |                                             |
|--------------------------------------------------|----------------------------------|-----------------------------------------------|---------------------------------------------|
| <b>DESCRIPTION OF VALLEY FLAT</b>                |                                  |                                               |                                             |
| Presence:                                        | Extent:                          | Average width <1 mi                           | Vegetation:                                 |
| 0 none                                           | 0 none                           | Maximum width _____ mi                        | 0 0 not applicable                          |
| 1 indefinite                                     | 1 narrow (<1 Mi)                 | Channel length with valley flat on left _____ | 1 1 almost none or bare                     |
| 2 fragmentary                                    | 2 moderate (1-5 Mi)              | on right _____                                | 2 2 grass                                   |
| 3 continuous                                     | 3 wide (>5 Mi)                   |                                               | 3 3 shrubs                                  |
| Forest Type:                                     | Land Use:                        |                                               | 4 4 sparsely forested                       |
| 0 0 not applicable                               | 0 0 not cultivated, not built-up |                                               | 5 5 moderately forested                     |
| 1 1 deciduous                                    | 1 1 partly cultivated            |                                               | 6 6 heavily forested                        |
| 2 2 coniferous                                   | 2 2 mainly cultivated            |                                               | 7 7 swamp or muskeg                         |
| <b>CHANNEL DESCRIPTION (near long-term mean)</b> |                                  |                                               |                                             |
| Channel Pattern:                                 | Islands:                         | Type of Flow:                                 | Bar Type:                                   |
| 1 straight                                       | 0 none                           | 1 uniform water surface                       | 0 0 none                                    |
| 2 sinuosity                                      | 1 occasional                     | 2 uniform with rapid in reach                 | 1 1 point bars                              |
| 3 irregular                                      | 2 frequent                       | 3 uniform with boils and irregularities       | 2 2 side bars                               |
| 4 regular meanders                               | 3 split                          |                                               | 3 3 mid-channel bars                        |
| 5 irregular meanders                             | 4 braided                        |                                               | 4 4 diagonal bars                           |
| 6 tortuous meanders                              |                                  |                                               | 5 5 large dunes                             |
| Natural Obstructions:                            | Degree of Obstruction:           |                                               | Meander Dimensions:                         |
| 0 0 none                                         | 0 0 none                         |                                               | belt width _____ mi                         |
| 1 1 logs                                         | 1 1 occ. minor                   |                                               | wave length _____ mi                        |
| 2 2 beaver dams                                  | 2 2 occ. major                   |                                               | sinuosity _____                             |
| <b>LATERAL CHANNEL ACTIVITY</b>                  |                                  |                                               |                                             |
| Lateral Activity:                                | Lateral Stability:               |                                               | Comments: _____                             |
| 0 not acceptable                                 | 0 stable                         |                                               | Comments: <u>irregular lateral activity</u> |
| 1 downstream progression                         | 1 slightly unstable              |                                               |                                             |
| 2 progression and cut-offs                       | 2 moderately unstable            |                                               |                                             |
| 3 mainly cut-offs                                | 3 highly unstable                |                                               |                                             |
| 4 entrenched loop development                    |                                  |                                               |                                             |
| 5 laterally active but not 1-4                   |                                  |                                               |                                             |
| <b>CHANNEL BANKS AND BED</b>                     |                                  |                                               |                                             |
| Alluvial Bank Material:                          | Non-alluvial Bank Material:      |                                               |                                             |
| 0 0 no alluvial banks                            | 0 0 alluvial bank material       |                                               |                                             |
| 1 1 clay and silt (cohesive)                     | 1 1 lacustrine deposits          |                                               |                                             |
| 2 2 silt and sand (non-cohesive)                 | 2 2 2 till                       |                                               |                                             |
| 3 3 sand and gravel (<64 μ)                      |                                  |                                               |                                             |
| Percentage of left bank in alluvium _____        |                                  |                                               |                                             |
| Percentage of right bank in alluvium _____       |                                  |                                               |                                             |
| Bank Vegetation:                                 | Depth of Alluvium:               | Estimated depth of alluvium _____ ft          |                                             |
| 0 none                                           | 0 no alluvium                    | Reference or comments: _____                  |                                             |
| 1 weak                                           | 1 shallow                        |                                               |                                             |
| 2 good                                           | 2 moderate                       |                                               |                                             |
| 3 very strong                                    | 3 deep                           |                                               |                                             |
| <b>BED ROCK BELOW CHANNEL</b>                    |                                  |                                               |                                             |
| Presence of Rock Outcrops in Channel Bed:        | Rock Type at Channel Base:       | Erodibility:                                  | Comments: _____                             |
| 0 none                                           | 0 0 not applicable               | 0 0 not applicable                            |                                             |
| 1 one occurrence                                 | 1 1 (none for great depth)       | 1 1 soft cohesive                             |                                             |
| 2 two occurrences                                | 2 2 compact clay                 | 2 2 2 easily erodible                         |                                             |
| 3 several occurrences                            | 3 3 shale                        | 3 3 3 moderately erodible                     |                                             |
|                                                  | 3 3 limestone                    | 4 4 resistant                                 |                                             |

Within the two reaches of interest, a number of sample sites were selected for monitoring the morphology, sediments and fisheries. Photographs were taken prior to, during and following the test flow releases at the various stations. An example of a photo set from Station III (km 6.5) (see Fig. 8) is included. However, little morphological change was detected at any site using the photographic technique. An example of some morphological change is presented in Fig. 6, where a small backchannel only occupied at peak flows was actively enlarging its channel on the floodplain.

(c) Sediment Sampling

At Stations III and IV, bed material samples were taken using the tape grid technique as described by Bray (1971). Plan view and cross-section sketches of the two Stations III and IV are shown in Figs. 9 and 10 respectively. Table 3-4 gives a coded description of the stations, the tape grid sample data are summarized in Tables 3-5 and 3-6.

The samples indicate that the coarsest bed material being transported by the Cheakamus River in the middle reaches ranges from 45 to 160 mm diameter, with an average size of 98 mm. This size material forms an armor layer of clean-washed, well-rounded, slightly imbricated clasts over the bar surfaces. The armor layer, where tested was about 10 to 30 cm thick with little fine-grained interstitial material, overlying coarse sand to fine gravel.

Four gravel displacement indicators, as described in Section 3.1, were installed at Stations III and IV (for specific locations, see Figs. 9 and 10). Test results showed that the chain indicators at the lower Cheakamus site (Station III) were not displaced. At Station IV, the bar surface was apparently mobilized during the test flows, as the bar surface was lower by 17 cm and both chain indicators were 30 cm lower.

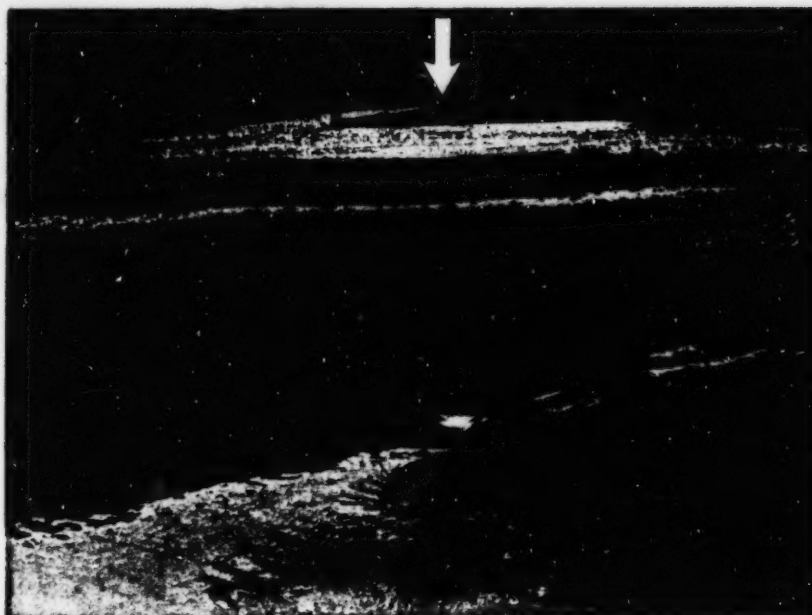
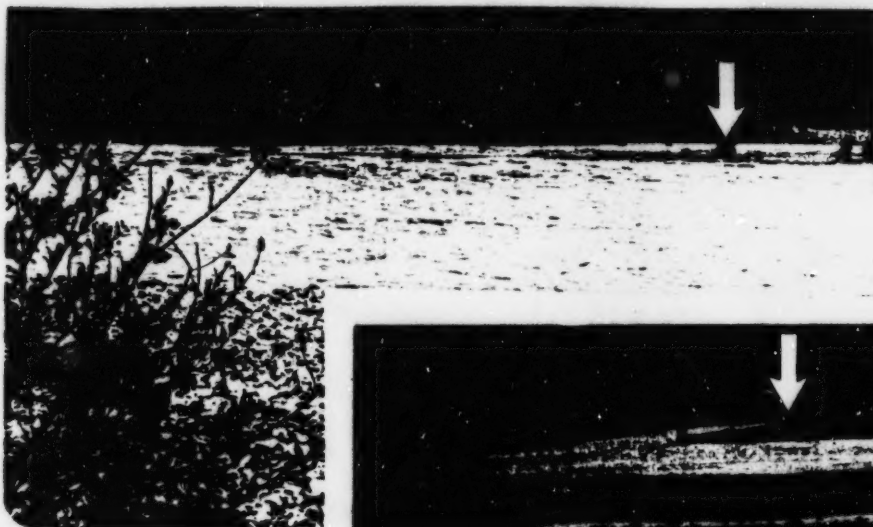


Fig. 8 - Sample Station III

|        |               |         |
|--------|---------------|---------|
| Top    | 2 August 1983 | 57 cms  |
| Middle | 3 August 1983 | 250 cms |
| Bottom | 3 August 1983 | 65 cms  |

Note shrub indicated by arrow for reference point. Increased cut bank erosion in front of shrub, minor channels cut on bar surface in foreground. Sand deposited at downstream end of bar during falling stages.

TABLE 3-4  
DESCRIPTION OF BED-MATERIAL SAMPLING SITE, CODES

| Sample No. | Type | Location to MS | Geomorphic Unit | Loc. on Geo. Unit | Lateral Location | Longitudinal Location | Direction | Pavement | Activity | Representativeness | Particle Shape | Particle Lithology |
|------------|------|----------------|-----------------|-------------------|------------------|-----------------------|-----------|----------|----------|--------------------|----------------|--------------------|
| IVN        | 2    | Below MS       | 1               | 2                 | 2                | 1                     | 1         | 2        |          | 1                  | 2              | 1, 12              |
| IIIN       | 1    | 0              | 1               | 2                 | 1                | 2                     | 1         | 2        |          | 1                  | 2              | 1, 12              |

NOTE: Use "1" for "unknown" and use multiple codes where necessary.

SAMPLE NO.: Station - Year - Type - No. TYPE: Grid-by-number = H  
(e.g.) 10 70 N 3 Photo = P  
Sieve = S  
(10-70-MS)

| SAMPLE TYPE                | LOCATION IN RELATION WATER SURFACE | GEOMORPHIC UNIT         | LOCATION ON GEOMORPHIC UNIT | LATERAL LOCATION IN CHANNEL |
|----------------------------|------------------------------------|-------------------------|-----------------------------|-----------------------------|
| 1 tape grid                | 0 at edge of water                 | 0 no particular feature | 0 not applicable            | 0 not applicable            |
| 2 stepping (tee) grid      | 1 (n) n ft above water surface     | 1 side bar              | 1 near upstream end         | 1 near left bank            |
| 3 grid photo               | 2 (n) n ft below water surface     | 2 point bar             | 2 near centre               | 2 near left quarter point   |
| 4 sieve, including surface |                                    | 3 mid-channel bar       | 3 near downstream end       | 3 near centre               |
| 5 sieve, excluding surface |                                    | 4 island                |                             | 4 near right quarter point  |
|                            |                                    | 5 in pool               |                             | 5 near right bank           |
|                            |                                    | 6 at riffle             |                             |                             |
|                            |                                    | 7 at cross-over         |                             |                             |

| LONGITUDINAL LOCATION       | DIRECTION OF LINEAR GRID SAMPLES | PAVEMENT CODES                         | ACTIVITY CODE                         |
|-----------------------------|----------------------------------|----------------------------------------|---------------------------------------|
| 1 relatively straight reach | 0 not applicable                 | 0 no apparent pavement                 | 0 no indication of recent movement    |
| 2 bend to left              | 1 parallel to flow               | 1 only fines removed from surface      | 1 indication of recent minor movement |
| 3 bend to right             | 2 perpendicular to flow          | 2 obviously larger material at surface | 2 indication of recent major movement |
|                             | 3 ( ) at degrees to flow         |                                        |                                       |

| REPRESENTATIVENESS CODE      | PREDOMINANT PARTICLE SHAPE | PREDOMINANT PARTICLE LITHOLOGY |
|------------------------------|----------------------------|--------------------------------|
| 0 not representative of site | 1 spherical and rounded    | 1 granite                      |
| 1 estimated average for site | 2 elongate and rounded     | 2 gneiss                       |
| 2 coarsest material at site  | 3 angular                  | 3 basalt                       |
| 3 finer than average         | 4 platy                    | 4 quartzite                    |
|                              |                            | 5 slate                        |
|                              |                            | 6 schist                       |
|                              |                            | 7 limestone                    |
|                              |                            | 8 dolomite                     |
|                              |                            | 9 conglomerate                 |
|                              |                            | 10 sandstone                   |
|                              |                            | 11 shale                       |
|                              |                            | 12 volcanics                   |

TABLE 3-5  
LOWER CHEAKANUS SITE

ANALYSIS OF BED MATERIAL: GRID-BY-NUMBER

|                  |                             |                 |            |             |        |
|------------------|-----------------------------|-----------------|------------|-------------|--------|
| Sample No.:      | 111N                        | Analysis By:    | S. Blachut |             |        |
| Size Range<br>mm | Tally                       | No. in<br>Range | $\Sigma$   | Than $\phi$ | $\phi$ |
| 4 - 7            |                             |                 |            |             | -3     |
| 8 - 15           |                             |                 |            |             | -4     |
| 16 - 30          |                             |                 |            |             | -5     |
| 32 - 63          | ////                        | 5               | 5          | 12.5        | -6     |
| 64 - 127         | //// //// //// //// //// // | 27              | 32         | 80          | -7     |
| 128 - 255        | //// ///                    | 8               | 40         | 100         | -8     |
| 256 - 511        |                             |                 |            |             | -9     |
| 512 - 1023       |                             |                 |            |             | -10    |

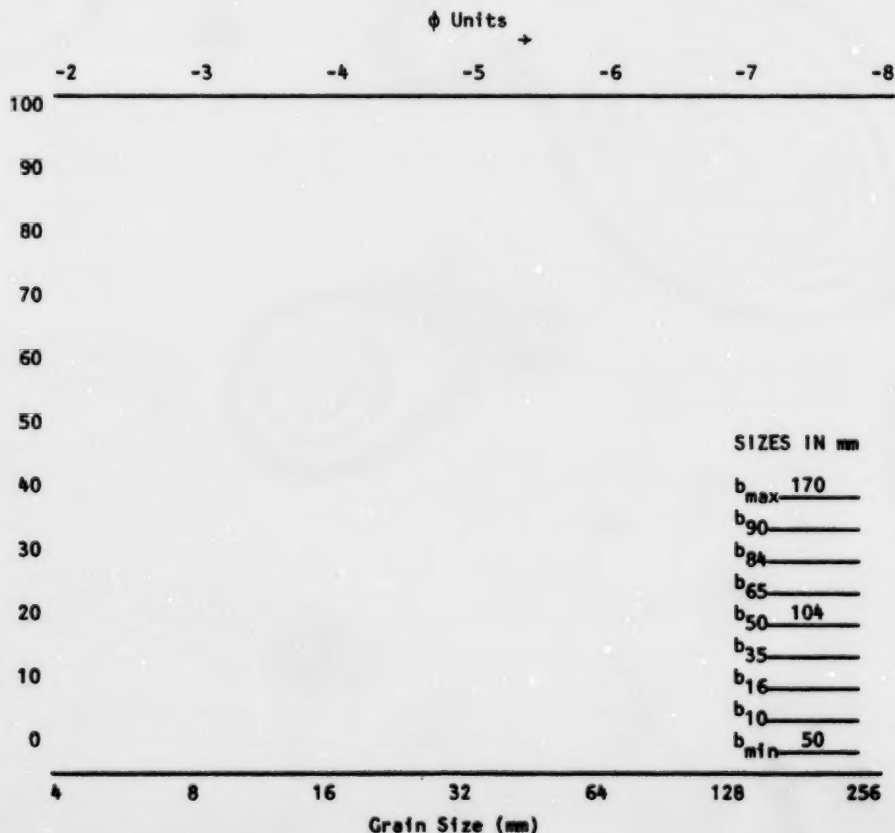


TABLE 3-6  
MIDDLE CHEAKAMUS SITE

ANALYSIS OF BED MATERIAL: GRID-BY-NUMBER

|                  |                        |                 |                   |             |        |
|------------------|------------------------|-----------------|-------------------|-------------|--------|
| Sample No.:      | <u>IVN</u>             | Analysis By:    | <u>S. Blachut</u> |             |        |
| Size Range<br>mm | Tally                  | No. in<br>Range | $\Sigma$          | Than $\phi$ | $\phi$ |
| 4 - 7            |                        |                 |                   |             | -3     |
| 8 - 15           |                        |                 |                   |             | -4     |
| 16 - 31          |                        |                 |                   |             | -5     |
| 32 - 63          | //// /                 | 6               | 6                 | 19.3        | -6     |
| 64 - 127         | //// //// //// //// // | 22              | 28                | 90.3        | -7     |
| 128 - 255        | ///                    | 3               | 31                | 100         | -8     |
| 256 - 511        |                        |                 |                   |             | -9     |
| 512 - 1023       |                        |                 |                   |             | -10    |

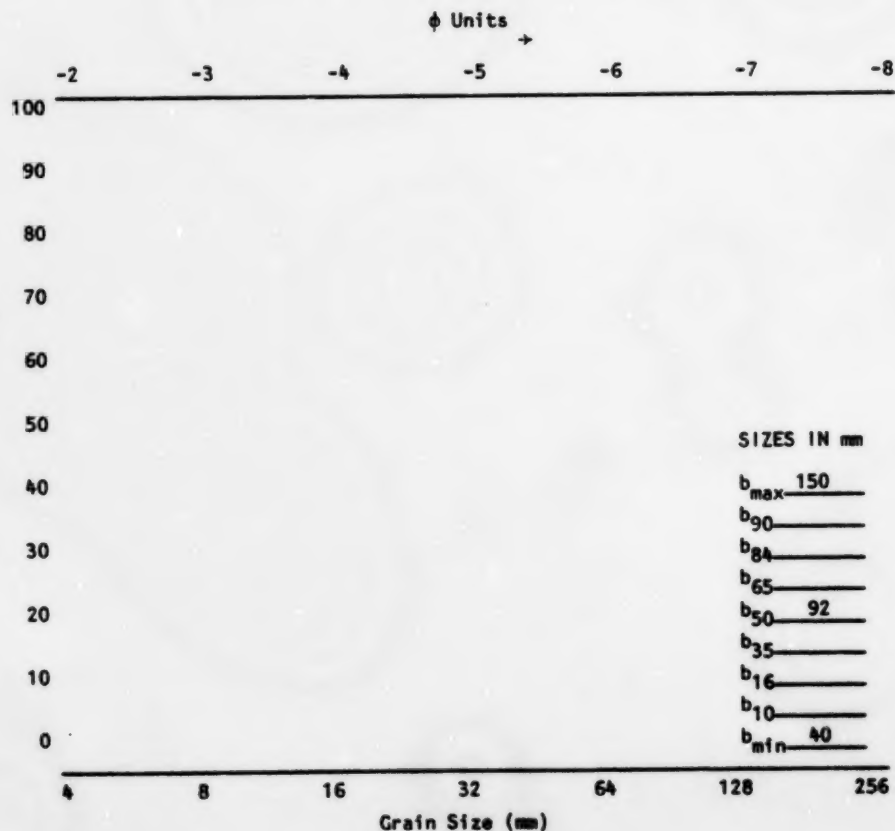
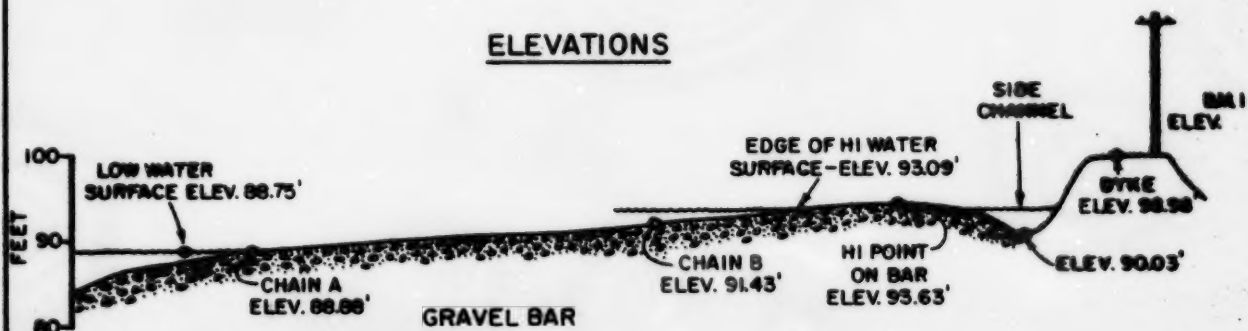
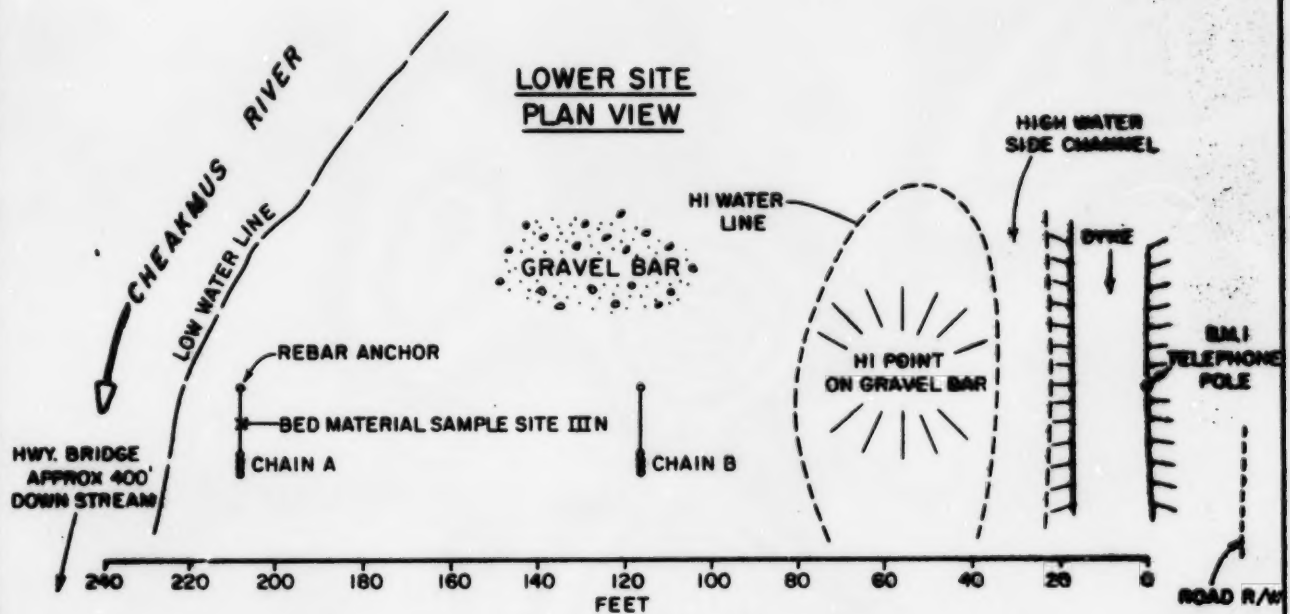


Figure 9  
LOWER CHEAKAMUS REACH  
STATION III



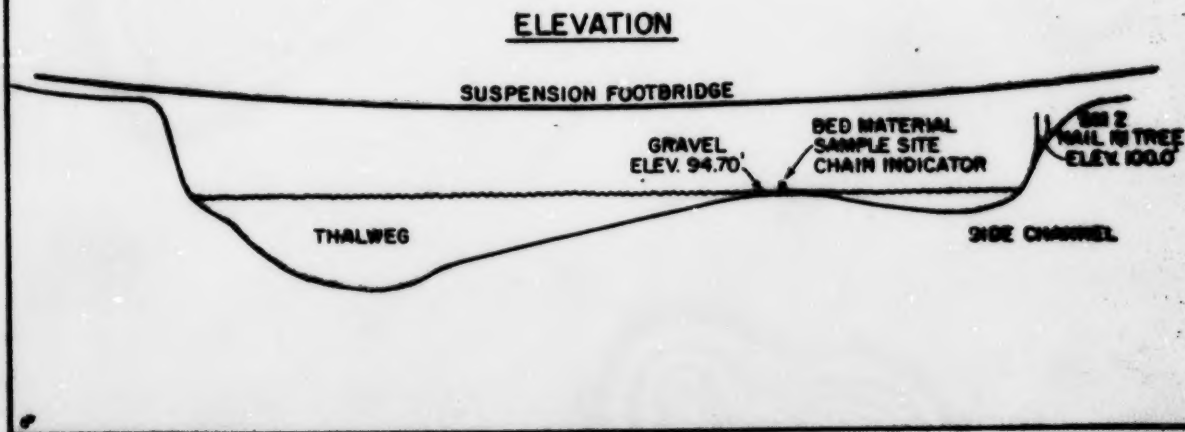
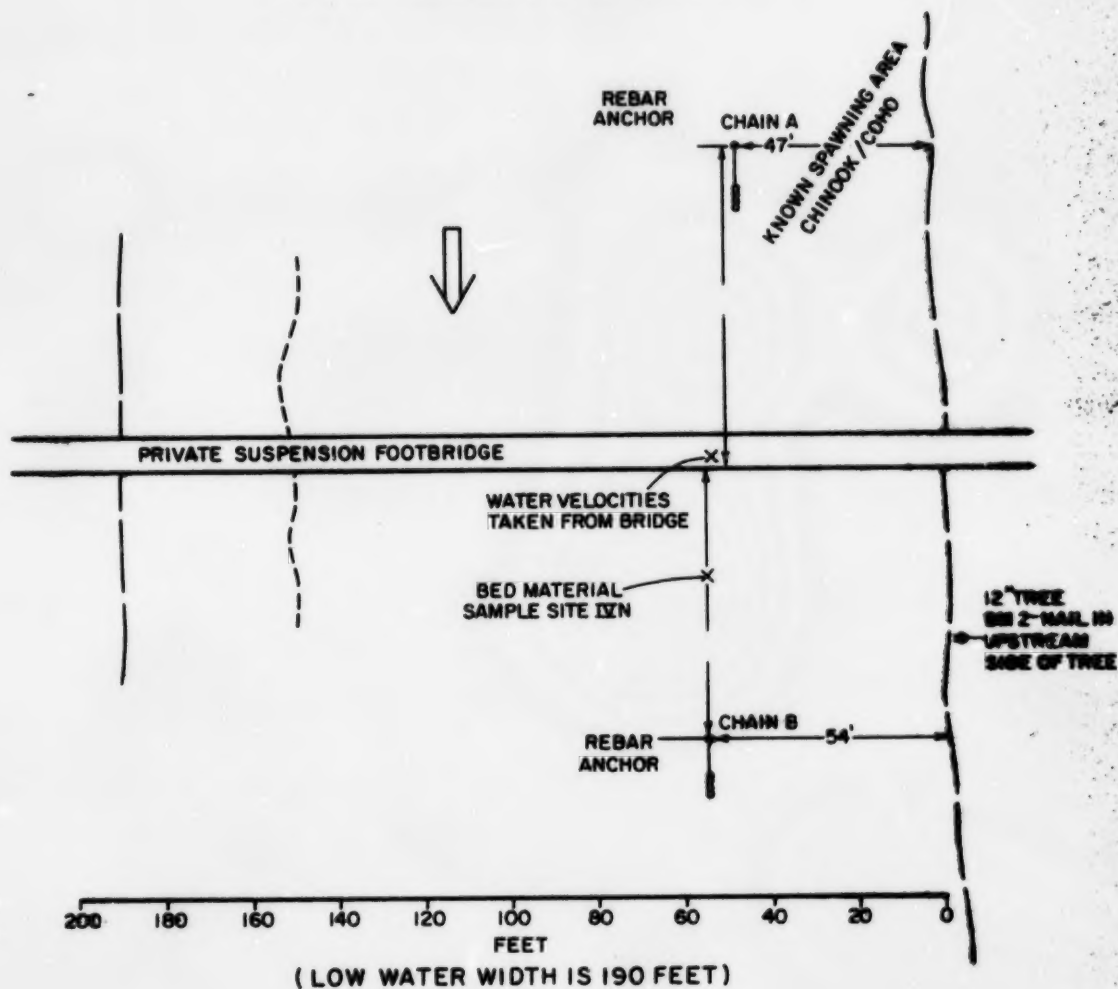
NOTE: BM I IS NAIL IN UPSTREAM SIDE OF TELEPHONE POLE ON DYKE

NOTE LOCATION OF CHAINS A & B, GRAVEL DISPLACEMENT INDICATORS.

SURVEYED BY:  
G. P. FOLS  
& G. L. CLARK

Figure 10  
MIDDLE CHEAKAMUS REACH  
STATION IV

NOTE CHAIN GRAVEL DISPLACEMENT INDICATORS



The test flows were apparently sufficient to mobilize the bed material including the armor layer and the upper 30 cm of the underlying substrate at Station IV. The net lowering of the bar surface by 17 cm should be interpreted cautiously, as it was the average of only two spot measurements.

At Station III, there was no apparent movement of the bed material based on the two samples taken. This could be attributed to spatial heterogeneity of bed material movement. The sample sites were close to the mid-channel flank of a wide side bar in an approximately 200 m wide section. Although not measured, the channel gradient is lower at Station III than at Station IV. Finally, velocities were not measured at Station III, and it is possible that the velocity required for the critical tractive force was not reached.

## SECTION 4.0 - DISCUSSION

### 4.1 FISH

The Cheakamus River is used by anadromous fish during their spawning, incubation, and (for certain species) rearing life history stages. Only rainbow trout fry and coho juveniles were observed during this test. The biological observations were therefore concentrated on juvenile stranding and the conditions associated. The measurements of bed load disturbance were made to investigate the effects of similar flow changes on spawning or incubation stages.

Observations of fish stranding revealed that the rapid fall of river stage after the test resulted in many temporary pools being created on the newly emerging shoreline. These pools frequently drained slowly and were isolated from the main river. Several such pools contained juvenile fish which were mainly the rainbow trout fry. The larger coho salmon juveniles were far less abundant. Invertebrate aquatic forms of various groups were also stranded along the shoreline and in the pools. Stranding would be reduced with a slower falling (ramping) rate such as 2.5 cm/h (1 in/h) proposed by Tennant (1976). The estimated rate at Station I during this test was 165 cm/h (65 in/hr).

### 4.2 BED LOAD

Bed material and its movement is a significant factor in the spawning habitat of salmonids. A more extensive bed material sampling program and a larger grid of depth of disturbance indicators is recommended for subsequent test studies where spawning habitat is a concern. Interpretation of bed material samples and disturbance indicators must be made with caution. The spatial heterogeneity of bed material movement makes both sampling design and interpretation of results difficult. The depth of disturbance indicator, with further testing

may prove to be a simple yet valuable tool in determining disturbance of spawning gravels. Traditional methods of bed load transport measurement and calculation, and techniques such as freeze-core sampling (Everest et al, 1981) are more complicated and expensive, but neither provide the information on depth of bed material disturbed.

#### 4.3 MORPHOLOGY

The flow releases of the 3 August test peaked at about 300 m<sup>3</sup>/s, almost nine times the mean annual flow of 35 m<sup>3</sup>/s. Such an event of moderate magnitude and moderate frequency would be expected to cause some morphologic change (Wolman and Miller, 1960). However, the geomorphology of the Cheakamus River which is confined and entrenched for much of its length, is not conducive to major morphologic change, even at the bank full stages experienced at 300 m<sup>3</sup>/s.

Reach 2 (km 3 to 8) is most susceptible to change, with its irregular channel pattern flowing through alluvium and the presence of islands and bars. Comparison of 1976 air photos and 1983 field observations, indicates major channel pattern changes, including a shift in the location of the thalweg, between km 6 and 7. It is likely that the large flood event of 27 December 1980 (712 m<sup>3</sup>/s - maximum mean daily discharge on record) was responsible for much of the major morphologic change noted between the 1976 air photos and the present. It should also be noted that a storm-generated flow event of comparable magnitude (303 m<sup>3</sup>/s on 12 July) occurred recently, with little apparent effect.

However, very little morphological change was noted after the present test flow release, other than some minor bank cutting near the bank full stage (see Fig. 8). Near Station III, floodwaters carried by a small channel passing through the wooded floodplain and following the transmission line right-of-way was not performing any major erosive work, although it did carry some fish into this "overflow channel" (see Fig. 6). Interpretation of this feature is complicated by man-made bank protection works and culverts along this river reach.

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